

Teaching Pre-medical Science to large groups: matching teaching and learning styles in higher education

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This study compares the various preferred learning styles of students in a large Pre-medical Science class with the various preferred teaching styles of the lecturers. It includes an analysis and evaluation of the teaching methods and aids actually used by lecturers. Critical analysis of the data revealed that students have a stronger preference for being taught by means of co-operative and active teaching/learning experiences than their lecturers have for using such means. The emphasis of the study thus falls on the importance of actively involving students in the teaching/learning process by way of co-operative teaching/learning methods. This would be likely to enhance the students' ability to utilise cognitive skills such as creative thinking, interpretation, critical thinking and problem-solving.

Groot Pre-mediese Wetenskapklasse: gepaste hoëronderwys-onderrig- en leerstyle

Hierdie studie vergelyk die voorkeur van verskillende leerstyle onder studente in 'n groot klas vir Premediese Wetenskap met die voorkeur in onderrigstyle van hul dosente. In die studie word 'n analise en evaluering ingesluit van die onderrigmetodes en hulpmiddels wat huidiglik deur hierdie groep dosente gebruik word. Dit analiseer en evalueer ook die huidige onderrigmetodes en hulpmiddele wat hierdie groep dosente gebruik. 'n Kritiese analise van die data toon dat studente 'n groter voorkeur toon vir koöperatiewe en aktiewe onderrig-/leerervaringe as vir die tradisionele onderrigmetodes wat tans deur dosente gebruik word. Die studie beklemtoon verder die belangrikheid dat studente aktief en koöperatief betrokke sal wees in die onderrig-/leerproses. Daardeur kan kognitiewe vaardighede, soos kreatiewe denke, interpretasie, kritiese denke en probleem-oplossende denke ontwikkel word.

When entering the university environment, students need to make numerous complex adjustments, including adapting to new teaching methods and mastering new learning skills (Ferraira 1995: 154-8). Since the 1990s, a significant growth has been discerned in the number of students from a diversity of educational, linguistic, cultural and socio-economic backgrounds attending medical faculties at South African universities. At the majority of universities, pre-medical courses in the first two years often carry enrolments of hundreds of students. Such large class settings have historically been heavily lecture-centred. In order to accommodate diversity and reduce attrition rates, some institutions are undertaking wide-scale reviews of curricula and teaching methods at both departmental and faculty levels (Cuseo 2004, Ferraira 1995: 154-8).

Despite the wide range of teaching styles available, lecturers regrettably tend to opt for those which match their own learning styles, partly because they instinctively tend to teach in the ways they themselves were taught. This effectively means that at times not all of the students manage to derive benefit from the teaching-learning situation (Felder 1996 & 2005, Goodman *et al* 2005).

Medical educators often employ the lecture format in the undergraduate classroom, expecting students to learn concepts by reviewing their lecture notes and the prescribed textbook (Cuseo 2004). Evidence suggests, however, that exclusive use of this mode of instruction in large groups (51-300 students) is ineffective and creates an unproductive learning experience for many students (Cuseo 2004, Lujan & DiCarlo 2006) which may encourage them to turn to rote memorisation, a form of passive learning (Goodman *et al* 2005, Kumar 2003). The following are deleterious outcomes of this mode among large groups (Cantillon 2003, Cuseo 2004, Goodman *et al* 2005):

- increased reliance on the lecture method of instruction;
- reduced frequency of lecturer interaction with, and feedback to, students;
- less active learning on the part of students;
- reduced depth of student thinking in the classroom;

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- reduced overall course satisfaction in respect of the learning experience, and
- lower levels of academic performance and learning achievement.

Modern teaching trends in medical education exhibit a paradigm shift from conventional classroom teaching methods to non-conventional methods designed to encourage interactive forms of learning. These, however, are sometimes difficult to apply to large groups (Sefton 2000: 64-71).

Moreover, students have different learning styles and any mismatch between the teaching styles of lecturers and the learning styles of students can have negative consequences (Felder 1993 & 1996). Students who experience such a mismatch feel as though they are being addressed in a foreign language. They tend to obtain lower marks than students whose learning styles are better matched to the lecturers' teaching styles (Felder 1996).

Such problems can be minimised and the quality of Pre-medical Science teaching significantly enhanced if lecturers modify and/or vary their teaching styles to accommodate the learning styles of more of the students in their classes. Although it is impossible to accommodate all learning styles simultaneously, it is possible to incorporate a small number of additional teaching methods in a class on a systematic basis in order to meet the needs of more, or even all students (Felder 1993 & 1996, Wilke 2003).

The objectives of the study reported here were as follows:

- to determine the preferred learning styles of students in a large Pre-medical Science class;
- to determine the preferred teaching styles of the lecturers teaching the class;
- to analyse the teaching methods and teaching aids used for this class by the lecturers, and
- to make recommendations in respect of the most effective ways of teaching Pre-medical Science to large groups.

1. Method

1.1 Research design

The study was conducted in Pre-medical Science (Physiology) during the course of 2005. It involved all the second-year MBChB students at a medical university. As indicated above, it was designed to compare the preference of students for different learning styles with their lecturers' preference for different teaching styles. The study includes an analysis and evaluation of the actual teaching methods and aids used by the lecturers. The study was conducted during the final teaching block after students had been exposed to the lecturing styles used by their various lecturers. Two separate questionnaires were utilised in the study.

1.2 Structuring of questionnaires

Questionnaire 1 (completed by staff): A structured questionnaire was completed by staff responsible for lecturing Pre-medical Science. Part A of this questionnaire consisted of a 25-item, 5-variable structure to measure the teaching style preferred by the lecturer. A lecturer's actual use of various teaching methods was not measured in section A. Instead, the preference of each lecturer was gauged. The majority of the statements were introduced with a choice of replies, headed by the question: "Which of the following do you prefer ...?" Care was taken to ensure that the 25 questions covered all the variables listed below, without excessive coverage of any. The variables were selected from an existing model (Solomon & Felder 2004):

- Sensory or intuitive perception of information
- Visual, verbal or tactile perception of information
- Inductive or deductive reasoning
- Active or reflective processing of information
- Sequential or global progress to the understanding of information.

Section B evaluated the teaching methods and aids actually used by the lecturers. The methods comprised lecturing, questioning, discussion, demonstration, seminars, tutorials, case studies, peer teaching and projects. The teaching aids comprised chalkboard, transparencies, video/TV, PowerPoint presentations, posters/charts, models, textbook/handouts and simulations/plays. The options from which the lecturer could choose

in each case were “never”, “seldom”, “often” and “with every lecture”. The first two options were considered as a negative response and the last two as a positive one. Reasons for use or non-use were also requested.

Questionnaire 2 (completed by students): This questionnaire was completed by students in their second year. Section A corresponded with Section A of questionnaire 1, but the questions were adapted to determine the different learning styles students preferred in the teaching of Pre-medical Science. This questionnaire likewise consisted of 25 questions, aimed at measuring the preferences for the same variables as those used in the lecturers’ questionnaire. In section B, which corresponded with Section B of the questionnaire for lecturers, the teaching methods and teaching aids preferred by students were measured.

This questionnaire was piloted on about 5 to 10% of the final sample number. The results of the pilot study were not included in the final results. After permission had been obtained, Part A of each questionnaire was created and adapted from the *Index of Learning Styles Questionnaire* of North Carolina State University (Solomon & Felder 2004). Both questionnaires were discussed with local experts and sent for comment to Prof Richard M Felder, an international expert in the field.¹

1.3 Data collection

An empirical study was conducted by means of the two questionnaires. Care was taken in their design to ensure that the data collected could be organised and presented systematically so that valid and accurate conclusions could be drawn. Each of the nine lecturers in Pre-medical Science participated in the study by completing Questionnaire 1. This represents a response rate of 100%. In respect of Questionnaire 2, 140 of the 177 students polled returned their questionnaires (which were completed in class). This represents a response rate of 79%.

For the purposes of this study, the following classification was used in respect of group size: two students form a pair; three to nineteen students were taken to comprise a small group; twenty to 50 students made up an entire class, and 51 to 300 students constituted a large group (Van Aswegen *et al* 1993: 34).

1 Prof R M Felder 2005; e-mail correspondence on the 27/02/2005; rmfelder@mindspring.com.

1.4 Data analysis and statistical techniques

The statistical analysis of the results was carried out by the statistical consultation service ClinStat in Pretoria. The following test instruments were used:

- *T*-test procedure

The *t*-test assessed whether the means of the corresponding variables in the teaching styles and learning styles were differed statistically.

- Statistical significance (*p*-value)

The statistical significance of the results in this study must indicate the degree to which the results are representative of the population. Specifically, the *p*-value represents the probability of error involved in accepting the observed results (Ellis & Steyn 2003).

- Practical significance (effect size, *d*)

It was also important in this study to calculate and report measures of practical significance, known as effect size (*d*-value). The measure used in this study was Cohen's *d*-value (Cohen 1988, Steyn 2002).

2. Results

2.1 Comparison of the teaching styles of lecturers and the learning styles of students

The data collected by means of Questionnaire 1 Part A (the teaching styles preferred by the lecturers) were compared with the data obtained from Questionnaire 2 Part A (the learning styles preferred by the students). The results are presented in Table 1.

The students preferred multiple learning styles, including the active learning mode (63.8%). The lecturing staff also preferred to teach in a variety of teaching modes. There was, however, an imbalance between visual and verbal modes. Most staff members preferred to use the visual mode (80.0%) while the students preferred the verbal mode (54.0%) to the visual (46.0%).

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Table 1: Comparison of lecturers' preferred teaching styles with students' preferred learning styles in a large Pre-medical Science class

Teaching/ learning style: Variable (modes)	Mean percentage score of students (N = 140)	Mean percentage score of lecturers (N = 9)	<i>p</i> -value	Pooled standard deviation	Effect size (<i>d</i> -value)
Perceiving information: Sensory Intuitive	69.6 30.4	75.6 24.4	0.429	21.58	-0.28 Small
Perceiving sensory information: Visual Verbal	46.0 54.0	80.0 20.0	0.005 **	27.41	-1.24 Large
Reasoning: Inductive Deductive	49.6 50.4	35.6 64.7	0.127	26.26	0.53 Medium
Processing information: Active Reflective	63.8 36.2	62.2 37.8	0.865	26.67	0.06 Very small
Under- standing information: Sequential Global	35.0 65.0	33.3 66.7	0.836	23.10	0.07 Very small

** $p < 0.005$ considered to be significant

2.2 Practical significance of this study (effect size, *d*)

It was deemed important in this study to calculate and report measures of practical significance, known as effect size (*d*-value). The statistical technique used in this study was "Cohen's *d*" (Cohen 1988). Cohen gives the following guidelines for the interpretation of test results such as those obtained in this study: very small effect sizes: $d = 0.0$ to 0.2 ; small effect sizes: $d = 0.2$ to 0.5 ; medium effect sizes: $d = 0.5$ to 0.8 and large effect sizes: $d = 0.8$ and higher.

The effect sizes established between the two groups for the variables considered were mostly very small except for the variables inductive/deductive, which was medium, and visual/verbal, which was large.

Effect sizes may be interpreted in terms of the percentage of overlap of the two groups. A small effect size indicates that the distribution of scores for the two groups overlaps largely; a large effect size indicates the opposite.

2.3 Comparison of student preferences with the traditional teaching methods and media used by lecturers to teach a large class

2.3.1 Teaching methods/media used by lecturers

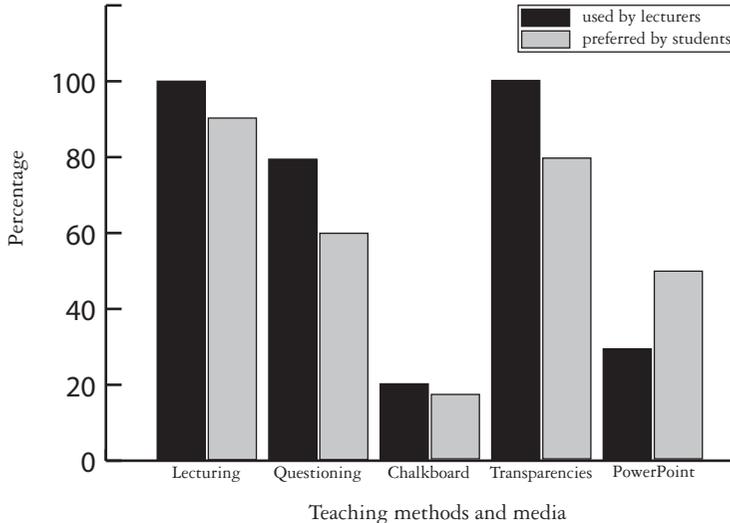
In Questionnaire 1 (Part B) lecturers were asked how often they used certain teaching methods and media: never, seldom, often, or in every lecture. In a corresponding item in Questionnaire 2, students were asked which teaching methods and media they preferred. In both questionnaires a glossary was provided, defining the respective teaching/learning methods. Graph 1 reflects some of the teaching methods and media traditionally used to teach large groups. The graph presents a comparison between the frequency of use with this group for each method/medium as indicated by lecturers (percentages refer to accumulative values for “often” and “with every lecture”) in comparison to the preference of students for each method/medium. The graph indicates 100% usage of the lecturing method (11% “often” and 89% “in every lecture”) with an accompanying 100% usage of transparencies and a 78% usage of questioning (56% “often” and 22% “with every lecture”). The chalkboard was described as used “often” by only 23%; PowerPoint presentations “often” by 22% and “in every lecture” by 12% (accumulatively 34%).

The following reasons for using or not using certain teaching methods were indicated by the lecturers:

- Why they did not use the teaching methods they indicated as “never” or “seldom”:
 - the two lecturers who did not use “questioning” indicated that it was “not practical for the group size”.

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Graph 1: Comparison of teaching methods and media used by lecturers in a large class with students' preferred methods and media.



- Why they were using the teaching media they indicated as “often” and “in every lecture”:
 - the three lecturers using the chalkboard and the nine lecturers using transparencies indicated that these were “easily available”, “effective for learning” and “user-friendly”;
 - the three lecturers using PowerPoint presentations indicated that these were “user-friendly” and “effective for learning”.

2.3.2 Teaching media preferred by students

Graph 1 indicates that the students had a slightly to moderately lower preference for the lecturing and questioning teaching methods as well as for the use of transparencies and the chalkboard as teaching media. They had a higher preference for PowerPoint presentations.

2.4 Comparison of active teaching methods used by lecturers with student preferences

For the purposes of this study, the following teaching methods were seen as associated with co-operative active learning. In the glossary to the questionnaires they were defined as follows:

- Discussion: dialogue between lecturer and students or among students in small groups, followed by feedback to the larger group.
- Seminars: a member of the group or the lecturer introducing a topic, followed by discussion on issues arising from the subject matter.
- Tutorials: like seminars, but focused on the difficulties experienced by students in understanding and using the subject matter.
- Case studies: simulation or (verbal/written) presentation of a real-life situation usually involving a problem to be solved by each group.
- Peer teaching: each member of the group becoming an expert on a topic and teaching it to his/her peers.

Graph 2 represents a comparison between the percentage (the accumulative value for “often” and “in every lecture”) of actual use of these methods by the lecturers in comparison with the students’ preference for them.

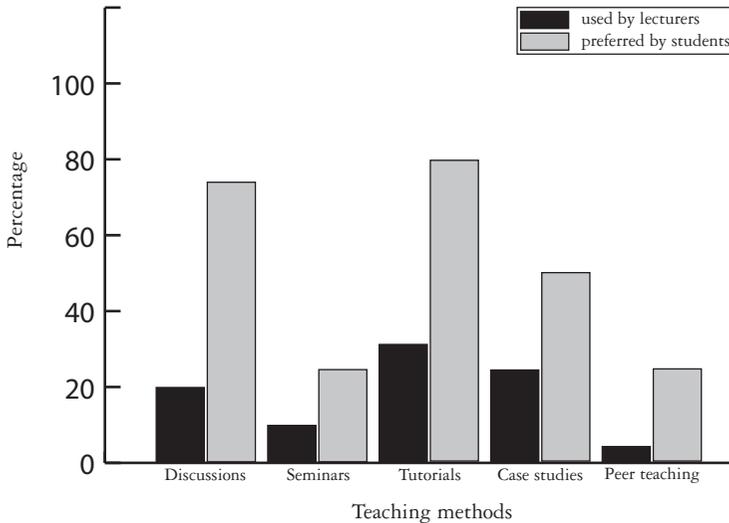
3. Discussion of results

3.1 Comparison of teaching styles of lecturers with learning styles of students

The results in Table 1 clearly indicate that both lecturers and students preferred a variety of teaching/learning styles. This corresponds with findings of numerous other studies which have indicated that students are capable of using various learning styles effectively (cf Felder 1993 & 1996, Lujan & DiCarlo 2006). To function effectively in any professional capacity one must work well in all learning-style modes (Felder 1996). Competent medical doctors and scientists must be observant, methodical, and careful (the sensory mode) as well as innovative and curious (the intuitive mode). Similarly, they must develop both visual and verbal skills. An objective of medical education should thus be to help students build their skills in both preferred and less preferred modes of learning.

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Graph 2: Comparison of percentage of different interactive teaching methods used by lecturers with percentage preferred by students



Although the preferred teaching styles of the lecturers in this study to some extent corresponded with the preferred learning styles of their students (very small to medium effect sizes), there was an exception in the visual/verbal mode (Table 1). Lecturers preferred to use visual presentations of material (pictures or diagrams), while the students were apparently more verbal learners whose preference was for written and spoken information. This corresponded with two other observations in this study:

- students indicated an 84% preference for using textbooks and/or handouts while lecturers recorded only a 22% usage of these aids, and
- students recorded a far higher preference than lecturers for active teaching methods such as discussions, seminars, tutorials and peer teaching, all of which depend largely on the verbal mode (Graph 2).

3.2 Practical significance of this study (effect size, d)

In three of the variables measured, the d -values (effect sizes) were very small or small. This indicates that there is no practical significant difference between the two groups and that both the teaching/learning modes were preferred by both students and lecturers. The only large effect size was found in the responses to questions about the visual/verbal mode (-1,24), which indicates that students and lecturers preferred opposing modes (Table 1).

3.3 Comparison of traditional teaching methods and media used by lecturers to teach a large class with student preferences

Lecturing or large-group teaching is one of the oldest forms of teaching and, whatever its reputation, the lecture can constitute an efficient means of transferring knowledge and effecting direct student learning (Cantillon 2003). However, it should not be regarded as an effective way of teaching skills, changing attitudes, or encouraging higher-order thinking. Large group formats tend to encourage passive learning in which students receive information but have little opportunity to process or critically appraise the new knowledge offered (Felder 1996, Han 2001).

The results reflected in Graph 1 indicate that the lecturers who participated in this study tended to rely heavily on the use of the traditional lecture format (with a high usage of lecturing, questioning and presentation by means of transparencies). The traditional lecture format is based on the assumption that all students will acquire the same information presented at the same pace. It therefore emphasises certain modes of learning while neglecting others (Goodman *et al* 2005). For example, the traditional lecturing method is primarily focused on the sensory mode (the visual and the verbal), while it neglects the intuitive and the active learning modes (Lujan & DiCarlo 2006). Most students are able to learn effectively as long as the lecturer blends different modes in his/her teaching style (Felder 1996). To achieve this goal, it becomes important to use additional active learning strategies such as discussions, seminars, tutorials, case studies and peer teaching.

3.4 Comparison of active teaching methods used by lecturers with student preferences

A growing body of research points to the value of undergraduate learning environments that set high expectations and promote active and interactive learning.² This research suggests that large classes are not the most effective venues for promoting retention of knowledge, critical thinking, problem-based thinking and attitude change. Furthermore, investigators have reported an increase in student achievement with the use of more active learning strategies such as discussions, seminars, tutorials, case studies and peer teaching (Lujan & DiCarlo 2006).

The results recorded in this study (Graph 2) clearly indicate that lecturers do not make sufficient effective use of co-operative and active teaching methods such as discussions, seminars, tutorials, case studies and peer teaching. The actual use of these five teaching methods by lecturers was recorded as between 7% and 34%, while the preference of the students for them was between 28% and 78%. These results do not correlate with the information contained in Table 1, which indicates that, as a group, the nine lecturers in Pre-medical Science preferred different teaching modes, particularly the active mode (63.8%). This indicates that these lecturers like to be actively involved in different teaching/learning experiences. The conclusion to be drawn from this is that lecturers were forced, for some reason, to make less use of these active teaching methods than they would have liked. The main reason given by them for their failure to employ such teaching methods was that to do so would not be “practical for the group size”. Five out of nine indicated this as their main reason, with only two indicating that such methods were “too time-consuming”. None of the lecturers chose the options “not an effective teaching method”, “I don’t feel comfortable with it” or “other” as the reason for not using them. They also clarified the reason for indicating “not practical for the group size”: the fact that teaching takes place in a large lecture room with rows of immovable seats is not conducive to small-group teaching.

Fortunately, there are ways of making teaching and learning in large classes almost as effective as in smaller classes (cf Felder 1997, Han

2. Cf Cuseo 2004, Goodman *et al* 2005, Lujan & DiCarlo 2006, Sefton 2002.

2001, Muffet 2001). In most cases, this demands a conscious awareness of instructional techniques and of the skills needed to use these correctly, as well as a great deal of planning, preparation, and coordination — for which lecturers may not have been trained. With reference to the results of this research, the following suggestions serve as examples for incorporating active student involvement:

- Encouraging student participation by having small group discussions on certain questions (in groups of three to four students, whether seated next to one another or behind one another). Graph 2 indicates that only 22% of lecturers used discussions “often”.
- Incorporating more 45-minute seminars and tutorials by dividing the large class into three or four smaller groups and moving them to adjacent locations. The lecturer can visit these groups regularly and the groups can provide feedback afterwards to the full class. In this study only 11% of lecturers indicated that they “often” used seminars and only 34% that they “often” used tutorials.
- Designing lectures around a problem-solving model or case-study model and leading the class through the discovery process. Active learning is promoted in this way and students should construct knowledge in the field to assimilate it most fully. Graph 2 demonstrates that only 25% of lecturers indicated that they “often” made use of case studies. Brief problem-solving class exercises in the form of case studies, requiring students to work in groups of three or four, can also be assigned to the class.
- Providing sufficient class time for students to consider the material presented (reflective) and to participate (active). Table 1 shows that 63.8% of students preferred active learning while 36.2% preferred reflective learning.
- Making use of out-of-class small group assignments and projects in order to increase co-operative and active learning. In this study 89% of the lecturers indicated that they “never” and 11% that they “seldom” made use of projects. They described such assignments as time-consuming and impractical in view of the size of the group. These obstacles can, however, be overcome by effective planning of mini-projects and by applying the rules of co-operative learning: positive interdependence, individual accountability, and appropriate use of teamwork skills.

- Using physical analogies (in the form of models) and demonstrations, moving into the aisles and around the lecture room, may encourage student involvement. In this study 38% “never”, 38% “seldom”, and 25% “often” made use of demonstrations, while 78% “never” and 22% “seldom” made use of models.

4. Conclusion

The above results emphasise the need to redesign the teaching of large groups in Pre-medical Science at the medical university concerned and to include more effective use of co-operative and active teaching strategies. An objective in teaching such large groups should thus be to help students develop their skills in both their preferred and their less preferred modes of learning. A “teaching style model” that categorises modes (as in Table 1) provides a good framework for designing instruction with the desired breadth. The goal must be to ensure that the learning needs of students in each mode are met at least some of the time. Felder (1996: 18-23) refers to this practice as “teaching around the cycle”.

The study, however, also indicated that the physical environment of the lecture forces lecturers to rely heavily on traditional lecturing, with little tendency to incorporate co-operative or active teaching/learning experiences. Large-group teaching can definitely offer an enriching learning experience to students, but this requires lecturers to put considerable effort into their planning. The study emphasised the importance of actively involving students in the teaching/learning process by means of co-operative and active teaching methods such as discussions, seminars, tutorials, case studies and peer teaching. Such involvement would enhance their ability to use cognitive skills such as creative thinking, interpretation, judgment, and problem-solving. In sum, thus, this study compared the preferred learning styles of students in a large Pre-medical Science group to the teaching styles of their lecturers and made recommendations on more effective teaching/learning.

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